

electric films 22D is substantially the same as the width of the diaphragm 21D, and is provided with fixed end areas 24D which are connected with the diaphragm 21D. The spacer 23D is in contact with a lower surface of the diaphragm 21D and upper surfaces of the plurality of piezoelectric films 22D and extends in the length direction of the vibrating device 20D over the plurality of piezoelectric films 22D so as to ensure a predetermined spacing between the diaphragm 21D and the plurality of piezoelectric films 22D. As a result, a plurality of piezoelectric films 22D are pushed downward in a thickness direction and are bent by the spacer 23D.

[0064] In the vibrating device 20D, the shape of each piezoelectric film 22D is a strip (rectangular) shape which is elongated in its length direction (the width direction of the vibrating device 20D). Therefore, when driven, each piezoelectric film 22D stretches or contracts primarily in its length direction. Consequently, by vibrating the diaphragm 21D including a plurality of these piezoelectric films 22D, it is possible to effectively vibrate the diaphragm 21D in its width direction. The spacer 23D ensures that the diaphragm 21D will be vibrated when the diaphragm 21D is pressed downwardly. Consequently, even when the tactile feedback device is composed of the vibrating device 20D, it is possible to present a tactile feedback to a user who performs the touch operation.

[0065] In the foregoing embodiment, a single spacer is disposed across a plurality of piezoelectric films. Alternatively, a plurality of shorter spacers may be individually disposed on respective piezoelectric films. By disposing a plurality of spacers on a plurality of piezoelectric films, it is possible to individually adjust a tension to be applied to each piezoelectric film, and therefore to more effectively vibrate the diaphragm.

[0066] Further, like the configuration illustrated in FIGS. 6(A) and 6(B), a plurality of spacers may be aligned in the length direction of each piezoelectric film in the present embodiment.

[0067] The present invention can be carried out as described above, yet the present invention can be carried out while employing configurations other than the above configurations as long as these configurations correspond to the claims. For example, the vibrating device according to the present invention may be used for other devices than the tactile sense presenting device such as a flat speaker.

1. A vibrating device, comprising:
  - a flexible diaphragm;
  - a film which deforms in response to the application of electrical energy thereto, the film being attached to the flexible diaphragm at two spaced locations with a major surface of the film facing a major surface of the flexible diaphragm; and
  - a spacer located between the two spaced locations and ensuring that the major surface of the flexible diaphragm is spaced from the major surface of the film.
2. The vibrating device in accordance with claim 1, wherein the vibrating device has a length, a width and a thickness, the flexible diaphragm and the film are spaced apart in the thickness direction and the flexible diaphragm is flexible in the thickness direction.
3. The vibrating device in accordance with claim 1, wherein the flexible diaphragm deforms in response to deformation of the film when electrical energy is applied to the vibrating film.

4. The vibrating device in accordance with claim 1, wherein the diaphragm vibrates in response to vibration of the film when an alternating electric voltage is applied to the film.

5. The vibrating device according to claim 1, wherein the spacer contacts both the flexible diaphragm and the film both before electrical energy is applied to the film and after electrical energy is applied to the film.

6. The vibrating device according to claim 1, wherein the spacer includes:

- a base portion facing the film; and
- a plurality of protrusion portions facing the diaphragm.

7. The vibrating device according to claim 6, wherein the base portion is in contact with the film and the plurality of protrusions are in contact with the diaphragm.

8. The vibrating device according to claim 6, wherein the vibrating device has a length, a width and a thickness extending perpendicular to one another and the spacer is elongated and extends in a length direction of the vibrating device.

9. The vibrating device according to claim 8, wherein the plurality of protrusions extend in the thickness direction of the vibrating device.

10. The vibrating device according to claim 8, wherein a plurality of the spacers are aligned in the length direction of the vibrating device.

11. The vibrating device according to claim 1, wherein the diaphragm has a flat shape when electrical energy is not applied to the film.

12. The vibrating device according to claim 1, wherein the film comprises a chiral polymer film or a polyvinylidene fluoride film.

13. A tactile feedback device comprising:

- (a) a vibrating device including:
  - (i) a flexible diaphragm;
  - (ii) a film which deforms in response to the application of electrical energy thereto, the film being attached to the flexible diaphragm at two spaced locations with a major surface of the film facing a major surface of the flexible diaphragm; and
  - (iii) a spacer located between the two spaced locations and ensuring that the major surface of the flexible diaphragm is spaced from the major surface of the film.
- (b) a touch sensor coupled to the diaphragm and generating an output signal in response to a touch operation; and
- (c) means for applying electrical energy to the film in response to the output signal.

14. The tactile feedback device in accordance with claim 13, wherein the vibrating device has a length, a width and a thickness, the flexible diaphragm and the film are spaced apart in the thickness direction and the flexible diaphragm is flexible in the thickness direction.

15. The tactile feedback device in accordance with claim 13, wherein the flexible diaphragm deforms in response to deformation of the film when electrical energy is applied to the film.

16. The tactile feedback device in accordance with claim 13, wherein the diaphragm, and with it the touch sensor, vibrates in response to vibration of the film when an alternating electric voltage is applied to the vibratory film.